ABSTRACT/PROJECT SUMMARY

Title: Storm Surge and Sea Level Rise on a Changing Landscape

Lead Institution: Louisiana State University

Investigators: Scott Hagen (lead), Louisiana State University and Steven Ashby (Co-PI), Northern Gulf Institute (NGI) at Mississippi State University

Budget Period: 9/1/2015 to 8/31/2016 Budget Total: $100,000

Statement of Need: Hampton Roads
The Hampton Roads region has seen sea level rise more than 14 inches since 1930. Hampton Roads is rated second only to New Orleans as the most vulnerable area to relative sea level rise in the country. Hampton Roads is home to the deepest water harbor on the U.S. East Coast, which hosts a robust shipbuilding and repair industry, a thriving export coal trade and the sixth largest containerized cargo complex in the United States, infrastructure currently at risk under current sea level rise scenarios. In addition, the region is recognized by the Department of Defense as the having the largest concentration of U.S. Military sites in the world, and frequently at risk to inundation by flood waters. This vulnerability has led to a growing need for integrated models and planning tools to make informed decisions that will enable coastal resilience and risk reduction in this critical area.

Advancing Sea Level Rise Models
Since 2010, NOAA National Centers for Coastal Ocean Science (NCCOS) has funded the Ecological Effects of Sea Level Rise-Northern Gulf of Mexico (EESLR-NGOM) project. EESLR-NGOM is a regional-scale project focused on the integration of a suite of observational measurements, field-based studies, and dynamic modeling capabilities resulting in a suite of tools that will enable more realistic assessments of sea level rise and storm surge impacts. Though still in the final stages, the project has resulted in two tools that enhance the ability of managers and planners to project the impacts of sea level rise.

Hydro-Marsh and Dynamic Storm Surge Tool
The Hydro-Marsh tool is an ADvanced CIRCulation model (ADCIRC)-based hydrodynamic model dynamically coupled with the process-based Marsh Equilibrium Model. This tool accounts for physical processes, such as tides and waves, and biological processes that interact to influence marsh erosion, accretion, and the ability of a marsh platform to "keep up" under varying scenarios of sea level rise. The Dynamic Storm Surge (Dynamic Surge) tool is also ADCIRC-based and is focused on quantifying the effects of sea level rise on the extent and depth of hurricane-induced storm surge. A core component of the Dynamic Surge tool is the recognition that landscapes evolve, particularly when faced with rising seas, and that projections of storm surge are strongly dependent on future landscape conditions. Bilskie et al. (2014) demonstrated this non-linear relationship between storm surge projections and sea level rise through re-creation of Hurricane Katrina. This analysis found that projected increases of urbanization in coastal areas exacerbated the extent of storm surge above what would have been expected from sea level rise alone. Conversely, projected changes in geomorphology (e.g., barrier island migration) served to shift the location of significant storm surge depth and extent, with some regions projected to have storm surge effects above what is expected from sea level rise alone while other regions had lower.

To address this issue and advance sea level rise/storm surge modeling, NOAA is participating in the Hampton Roads Sea Level Rise Preparedness and Resiliency Intergovernmental "Pilot." The Hampton Roads Pilot project is coordinating activities to maximize the effectiveness of Federal, state, local government, university, and private sector activities. In support of the Pilot, NOAA National Ocean Service (NOS) has launched a suite of targeted projects that leverage agency capabilities and investments to meet the needs of stakeholders in the Hampton Roads Region. As part of this effort, NOS and NCCOS are seeking to transition the Dynamic Surge tool, developed through EESLR-NGOM, for application in the Hampton Roads region.

Description of Work

The purpose of the requested work is to collaborate with NOAA and its partners to transition and apply the Dynamic Surge tool to the Hampton Roads region to quantify the dynamic effects of sea level and projected landscape changes on storm surge. Results from this project will be centered on scenario projections of storm surge depth and extent under a suite of storm conditions, sea level rise rates, landscape changes, and possible management actions. This project represents the first transition of the Dynamic Surge tool following its development in the Gulf of Mexico. In addition to the specific project activities identified below, the process and requirements for transition should be notified for possible future applications. Overall, this project represents a partnership between Louisiana State University and NOAA NCCOS.

Specific activities under this project include:

Activity 1: Given the number of ongoing activities related to, sea level rise, and coastal resiliency in the Hampton Roads region, coordination with relevant partners and maintaining a collaborative approach to project outputs will be critical. Core components of this activity include:

- Participate, in conjunction with NCCOS, in local workshops and meetings to maximize coordination with related efforts. It is anticipated that 2-3 trips to the Hampton Roads region and/or other location will be required to meet this component. Specific emphasis will be on collaborating with NCCOS to coordinate activities with related NOS-led activities, particularly those associated with NOAA's Office of Coastal Management, Center for Operational Oceanographic Products and Services, and the NOAA Storm Surge Roadmap. Participation and coordination early in the project will be critical for identifying specific conditions, parameters, and sea level rise scenarios for Dynamic Surge application.

- Coordinate, where appropriate, with existing storm surge modeling activities to leverage assets and results. This could include, but is not limited to use of existing ADCIRC model domains, digital elevation models, and bathymetric data sets.

- Collaborate with partners in the identification of core products and in the application of results. Partnerships with NOAA OCM and Virginia Sea Grant will be a critical aspect of this project component.

Activity 2: Transition and apply the Dynamic Surge tool to Hampton Roads region to quantify the interactive effects of landscape changes, sea level rise, on storm surge. The specific question to be addressed through this application is: How do dynamic processes and other landscape factors impact the development of storm surge projections and scenarios in the

Hampton Roads region? Specifically we will:

- Conduct assessments of storm surge extent and depth under a suite of scenarios and parameters to include those identified through Activity 1. It is anticipated that the assessment include multiple sea level rise scenarios, as well as projected changes in coastal geomorphology and in land use land cover. Inclusion of possible landscape-scale mitigation actions and concomitant effects should also be included, in consultation with NCCOS and local partners.

- Quantify the importance of incorporating dynamic processes in storm surge modeling relative to traditional storm surge modeling approaches.

Through these activities, it is anticipated that NOAA and local partners will have an enhanced ability to:

- Prioritize risk management strategies;
- Reformulate setback requirements;
- Improve guidelines for construction of breakwaters and other coastal infrastructure;
- Evaluate strategic alternatives and strategies for mitigation; and
- Assess water resource impacts and protection needs.

Reference: Bilskie, M.V., S.C. Hagen, S.C. Medeiros, and D.L. Passeri. 2014. Dynamics of sea level rise and coastal flooding on a changing landscape. Geophys. Res. Lett. 41 (3) (2014), pp. 234–927.